

# Electroencephalography (EEG) Based Mobile Robot Control through an Adaptive Brain Robot Interface

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## Abstract

This project mentioned a couple of brain controlled automaton supported Brain-computer interfaces (BCI). BCIs square measure systems that may by pass standard channels of communication (i.e., muscles and thoughts) to produce direct communication and management between the human brain and physical devices by translating totally different patterns of brain activity into commands in real time. With these commands mobile automaton may be controlled. The intention of the project work is to develop automaton that may assist the disabled folks in their standard of living to try and do some work freelance on others. Brain signals are detected by the brain wave device and it'll convert the info into packets and transmit through Bluetooth medium. Level instrument unit (LAU) can receive the brain wave information and it'll extract and method the signal victimization Mat lab platform. Then the management commands are transmitted to the robotic ARM module to method. With this whole system, we will choose AN object and place it consequently through the designed brain signals.

**Key words:** ARM; ZigBee; BCI; Pick and Place module.

## 1. Introduction

An EEG-based brain-controlled automaton could be automaton that uses EEG-based BCIs to receive human management (hereafter, brain controlled robots consult with EEG-based brain-controlled robots only). 2 main categories of brain-controlled robots to help disabilities art brain-controlled manipulators and mobile robots. One representative work of brain-controlled manipulators is that the manipulator used at intervals the FRIEND system developed by Grazer that is in a position to indicate the brain controlled capabilities of robots out of a controlled laboratory scenario.

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Brain-controlled mobile robots may be divided into 2 classes per their operational modes. One class is named “direct management by the BCI,” which suggests that the BCI interprets EEG signals into motion commands to regulate robots directly. Numerous approaches to implement this methodology are shown in Fig. I. One typical example is that the work of [1]. United Nations agency 1st developed a brain-controlled robotic chair whose left or right turning movements are directly controlled by corresponding motion commands translated from user brain signals whereas imagining left or right limb movements, and tested this technique in real-world things.

However, the performance of those brain-controlled mobile robots in the main depends on the performance of the noninvasive BCIs that are presently slow and uncertain [2]. In alternative words, the performance of the BCI systems limits that of the robots. Further, users ought to issue control commands rather of usually inflicting user fatigue.

To address the 2 queries said that the robots directly controlled by a BCI meet, thus on build the user be ready to management the automaton over a protracted amount of your time, the second cluster of brain-controlled robots has been developed from a perspective of shared management, wherever a user (using a BCI) associated an intelligent management (such as autonomous navigation system) share the control over the robots. The BCI interface and its control is explained by [3]

Block Diagram:

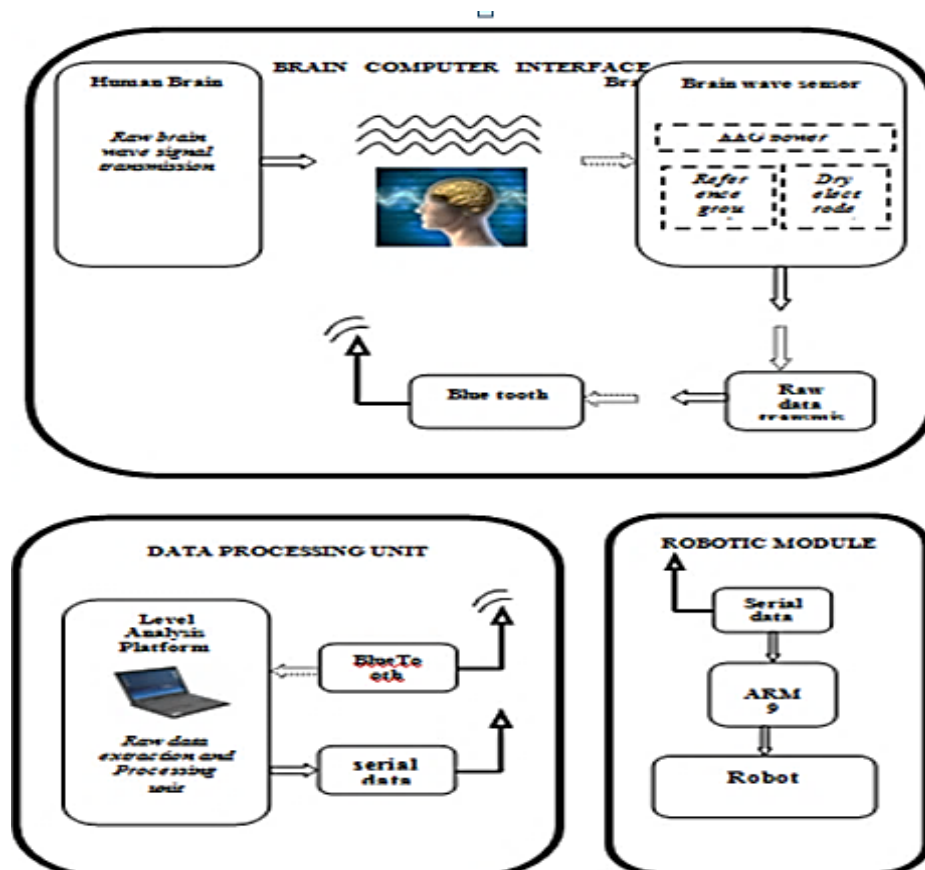


Figure 1: BCI- Pick and Place

## **2. Design and Implementation**

Electroencephalography (EEG) is that the activity of electrical activity within the living brain. during this project we tend to use a brainwave device MW001 to analyze the EEG signals [3] . This style discuss concerning processing and recording the raw EEG signal from the Mind Wave device within the MATLAB atmosphere and through ZigBee transmission management commands are passed to the robot section. Mind wave sensors don't seem to be utilized in clinical use [4] , however are utilized in the Brain management Interface (BCI) and neuro feedback (one of training program types). The BCI could be a direct communication pathway between the brain associate degree an external device.

### **2.1. Working Principle**

The principle of operation is kind of easy. 2 dry sensors are accustomed find and filter the EEG signals. The device tip detects electrical signals from the forehead of the brain. At constant time, the device devours close noise generated by human muscle, computers, lightweight bulbs, electrical sockets and alternative electrical devices [5] The second device, ear clip, could be a grounds and reference that permits think gear chip to strain the electrical noise. The device measures the raw signal, power spectrum (alpha, beta, delta, gamma, theta), attention level, mediation level and blink detection. [6] The raw EEG information received at a rate of 512 Hz. alternative measured values are created each second. Therefore, raw EEG information could be a main supply of knowledge on EEG signals victimization Mind Wave MW001.

### **2.2. Design Theory**

#### **2.2.1. Mat lab Platform**

The MATLAB permits to incorporate thinkgear.dll. This atmosphere has broad support in tool case that makes it ideal for a research project. This paper presents however, recording and processing the raw EEG signal in MATLAB atmosphere victimization Mind Wave device. The Communication Protocol shows a system of digital rules for message exchange between MATLAB atmosphere and Mind Wave MW001 device. This section additionally presents the most parameters of think gear library.

#### **2.2.2. The prescript**

The projected prescript could be a system of easy rules for message exchanges between MATLAB and therefore the EEG device. It consists of seven basic steps:

- ❖ Load Think Gear library into MATLAB
- ❖ Get a connection ID handle to Think Gear
- ❖ Attempt to connect the connection ID handle to serial port "COMx"
- ❖ Waiting to establish the connection
- ❖ Read packets from the connection
- ❖ Close the connection

#### ❖ Unload Think Gear library

In the opening move are functions with parameters within the following order::

1. libisloaded('Think gear') – returns true if the Think Gear library is loaded, and false otherwise.
2. . load library('Thinkgear.dll','thinkgear.h') – hundreds the functions outlined within the header file and located within the library. Now, the operate decisionlib() will call a operate within the Think Gear library.
3. calllib('Thinkgear', 'TG\_GetDriverVersion') – returns the version of loaded library.

In the next step, the operate calllib('Think gear', 'TG\_GetNewConnectionId') gets a brand new association ID handle to Think Gear. the worth -1 is came if too several connections are created.

In the ThinkGear library, the foremost vital operate is TG\_Connect. This operates wants four parameters: the association ID, variety of the interface, information measure and kind of knowledge. the amount of the interface is given throughout the pairing of the device. The device will connect on modes 1200, 2400, 4800, 9600, 57600 and 115200 bits per second (bps). Here, we have a tendency to use the 9600 bits per second rate and stream 5V RAW mode; as a result of these parameters we get the minimum of transmission errors.

#### **2.2.3. Chooses and Place module section**

We can scan the worth of raw electroencephalogram signal with the utmost frequency of 512 cycles. Frequency is about on 512 cycles, and that we management time delays in sampling. The worth of the signal and time are written to the array information. The data that are keep in array are going to be compared with the brink points given by the user. During this project, the Mat lab section waits for 3 consecutive blink so as to send the hardware activation signal. Then supported the eye level worth choose and Place module are going to be controlled. Supported the brain signal commands the thing is going to be picked and placed by the ARM module.

### **3. System Hardware**

#### **3.1. ARM-LPC2929**

**3.1.1.** The ARM968E-S may be a general purpose 32-bit RISC processor, that offers high performance and extremely low power consumption. The ARM design relies on Reduced Instruction Set Computer (RISC) principles, and therefore the instruction set and connected decrypt mechanism are abundant easier than those of micro programmed Complex Instruction Set Computers (CISC). This simplicity ends up in a high instruction outturn and spectacular period interrupt response from a tiny low and efficient controller core.

**3.1.2.** The LPC2929 mix associate ARM968E-S central processor core with 2 integrated Tightly Coupled Memory (TCM) blocks operative at frequencies of up to a hundred twenty five megacycle, Full-speed USB two.0 OTG and device controller, will and Maya Lin, 56 kB SRAM, up to 768 KB nonvolatile storage, external

memory interface, 3 10-bit ADCs, and multiple serial and parallel interfaces in an exceedingly single chip targeted at shopper, industrial and communication markets. To optimize system power consumption, the LPC2926/2927/2929 contains a terribly versatile Clock Generation Unit (CGU) that has dynamic clock gating and scaling.

Amongst the foremost compelling options of the ARM968E-S are:

- Separate directly connected instruction and information Tightly Coupled Memory (TCM) interfaces.
- Write buffers for the Advanced High performance bus (AHB) and TCM buses Pipeline techniques are utilized so all components of the process and memory systems will operate endlessly. The ARM968E-S relies on the ARMv5TE five-stage pipeline design. Typically, in an exceedingly three-stage pipeline design, whereas one instruction is being dead its successor is being decoded and a 3rd instruction is being fetched from memory. Within the five-stage pipeline further stages are adscititious for operation and write-back cycles. The ARM968E-S processor conjointly employs a novel bailiwick strategy referred to as THUMB, that makes it ideally suited to high-volume applications with memory restrictions or to applications wherever code density is a problem.

The key plan behind THUMB is that of a super-reduced instruction set. Primarily, the ARM968E-S processor has 2 instruction sets:

- Customary 32-bit ARMv5TE set.
- 16-bit THUMB set.

### **3.2. Brain wave sensor**

Electroencephalography (EEG) is that the measuring of electrical activity within the living brain. During this project we tend to use a brainwave device MW001 to analyze the EEG signals .This style discuss regarding process and recording the raw EEG signal from the Mind Wave device within the MATLAB setting and through ZigBee transmission management commands are passed to the mechanism section. Mind wave sensors aren't employed in clinical use, however area unit employed in the Brain management Interface (BCI) and neuro feedback (one of training program types). The BCI may be a direct communication pathway between the brains associated an external device.

#### **3.2.1. Think Gear ASIC Module**

- Directly connects to dry conductor (as critical standard medical wet sensors)
- One EEG channel with 3 contacts: EEG; REF; and GND
- Improper work detected through "Poor Signal Quality" warning from ASIC to reset if off the top for four consecutive seconds, or if it's receiving a poor signal for seven consecutive seconds

- Advanced filtering technology with high noise immunity
- Low power consumption appropriate for transportable battery-driven applications
- Gamma hydroxybutyrate power consumption 15mA @ three.3 V
- Raw EEG information output at 512 bits per second

Think Gear or TGAM Features + Technical Specifications.

#### Measures

- Raw brainwave signal
- Process and output of EEG power spectrums (Alpha, Beta, etc.)
- Process and output of NeuroSky proprietary essence meter for Attention, Meditation, and alternative future meters
- EEG/ECG signal quality analysis (can be wont to notice poor contact and whether or not the device is off the head)
- Eye blink detection

#### Electrodes

- Most extent of ~150mm<sup>2</sup> (but less extent is optimal)
- Ag/AgCl, chrome steel, Gold, or/and Silver (both solid and plated material works)
- EEG conductor settled higher than the left or right eye on the forehead
- Ground and reference electrodes settled behind the ear or at the lobe
- Have enough pressure to forestall movement, with a minimum of zero.8 PSI

### 3.3. L293D

L293D may be a twin H-bridge motor driver microcircuit (IC). Motor drivers act as current amplifiers since they take a low-current management signal and supply a higher-current signal. This higher current signal is employed to drive the motors. L293D contains 2 integral H-bridge driver circuits. In its common mode of operation, 2 DC motors are often driven at the same time, each in forward and reverse direction. The motor operations of 2 motors are often controlled by input logic at pins a pair of & seven and ten & fifteen. Input logic 00 or eleven can stop the corresponding motor.

Logic 01 and ten can rotate it in dextral and anticlockwise directions, severally.

DC motor:

DC motors are organized in many varieties and sizes, together with brush less, servo, and equipment motor varieties. A motor consists of a rotor and a permanent field mechanical device. The field is maintained mistreatment either permanent magnets or magnetism windings. Motors are the devices that give the particular speed and torsion during a drive system. This family includes AC motor varieties (single and point in time motors, universal, servo motors, induction, synchronous, and equipment motor) and DC motors (brush less, servo motor, and equipment motor) additionally as linear, stepper and air motors, and motor contactors and starters.

### **3. 4. IEEE 802.15.4 Protocol**

The XBee/XBee-PRO RF Modules [7] area unit designed to control among the ZigBee protocol and supports the distinctive desires of cheap, low-power wireless device networks. The modules need least power and supply reliable delivery of knowledge between remote devices. The modules operate among the philosophy a pair of.4 gigahertz band and area unit compatible with the subsequent.

#### ➤ Advanced Networking & Security

- Point-to-point topology
- Point-to-multipoint topology
- Self-routing, self-healing and fault- tolerant
- mesh networking

#### ➤ Low Power

- TX Current: 295 mA
- RX Current: forty five mA Power-down Current: < one  $\mu$ A

## **4. System software**

MATLAB's Graphical computer program Development surroundings (GUIDE) provides an upscale set of tools for incorporating graphical user interfaces (GUIs) in M-functions. Victimization GUIDE, the processes of birth out a GUI (i.e., its buttons, pop-up menus, etc.) and programming the operation of the GUI area unit divided handily into 2 simply managed and comparatively freelance tasks.

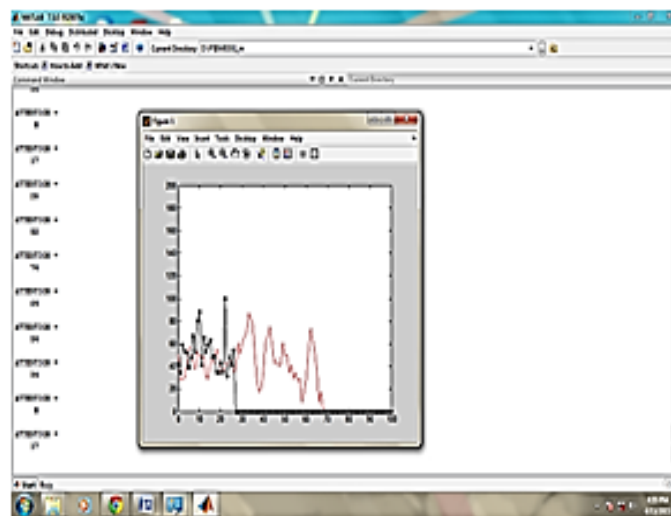
### **4.1. Role of Mat lab in BCI**

The MATLAB permits to incorporate thinkgear.dll. These surroundings have broad support in tool chest that makes it ideal for a research. This paper presents however recording and processes the raw graphical record signal in MATLAB surroundings victimization Mind Wave device. The Communication Protocol, shows a

system of digital rules in Fig. 2. for message exchange between MATLAB surroundings and Mind Wave MW001 device. This section conjointly presents the most parameters of think gear library.

The affiliation is established through command:

`calllib('Thinkgear','TG_Connect',Id,ComPortName,TG_BAUD_115200,TG_STREAM_5VRAW)`. Within the next step, we tend to should conceive to browse a Packet of knowledge from the affiliation. We tend to use the `TG_ReadPackets()` perform with ID parameter and range of packet to browse. The command `calllib('Thinkgear','TG_ReadPackets', Id,1)` returns false for error, and otherwise true. The perform `TG_GetValueStatus()` checks if a price has been updated by `TG_ReadPackets()`. If this perform returns true, we will use `TG_GetValue()` perform to urge the updated worth of the raw graphical record signal.



**Figure 2:** Brain signal representation in mat lab

The higher than graph illustration includes the eye price and blink strength. Supported this signals choose and Place module are going to be controlled. Supported the brain signal commands the item is going to be picked and placed by the ARM module.

## 5. Conclusion

This project mentioned a few brain controlled automaton supported Brain-computer interfaces (BCI). BCIs are systems which will bypass typical channels of communication (i.e., muscles and thoughts) to produce direct communication and management between the human brain and physical devices by translating completely different patterns of brain activity into commands in real time. With these commands associate object are often picked and placed in any atmosphere. This project can become associate helpful technology for disabled individuals in future.

## References

- [1] N. Birbaumer, T. Hinterberger, A. Kubler, and N. Neumann, "The thought-translation device (TTD):



- neurobehavioral mechanisms and clinical outcome,” *IEEE Trans. Neural Syst. Rehabil. Eng.*, vol. 11, no. 2, pp. 120–123, 2003.
- [2] K.-R. Muller and B. Blankertz, “Toward noninvasive brain-computer interfaces,” *IEEE Signal Process. Mag.*, vol. 23, no. 5, pp. 126–128, 2006.
- [3] J. Williamson, R. Murray-Smith, B. Blankertz, M. Krauledat, and K.-R. Müller, “Designing for uncertain, asymmetric control: Interaction design for brain–computer interfaces,” *Int. J. Hum. Comput. Stud.*, vol. 67, no. 10, pp. 827–841, 2009.
- [4] B. Hong, F. Guo, T. Liu, X. Gao, and S. Gao, “N200-speller using motion-onset visual response,” *Clin. Neurophysiol.*, vol. 120, no. 9, pp. 1658–1666, 2009.
- [5] D. J. McFarland, “Brain–computer interfaces for communication and control,” *Clin. Neurophysiol.*, vol. 113, no. 6, pp. 767–791, 2002.
- [6] J. E. Hall, *Guyton and Hall textbook of medical physiology e-Book*. Elsevier Health Sciences, 2015.
- [7] F. Arrichiello, P. Di Lillo, D. Di Vito, G. Antonelli, and S. Chiaverini, “Assistive robot operated via P300-based brain computer interface,” in *Robotics and Automation (ICRA), 2017 IEEE International Conference on*, 2017, pp. 6032–6037.